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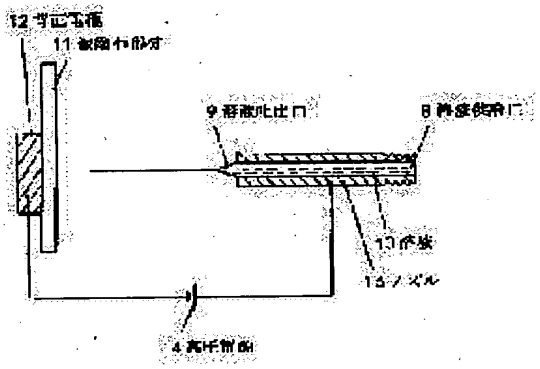
(54) FORMATION OF THIN FILM AND DEVICE THEREFOR

(57)Abstract:
PURPOSE: To form a fine thin film by utilizing an electrostatic force alone or the electrostatic force and a piezoelectric effect as an auxiliary as a means for discharging a film forming material consisting of a soln.-like substance, discharging the soln. of the material in a stringy state, heating the soln. or allowing the soln. to stand at room temp. to vaporize the solvent in the soln.
CONSTITUTION: A soln. 10 contg. a thin film forming material and a solvent dissolving the material and having ≥105Ωcm resistivity is discharged from a nozzle 13 in the direction of a member 11 to be coated with an electric field generated by impressing a voltage between a back electrode 12 and the nozzle 13 from a high-voltage power source 14. At this time, the soln. 10 is discharged in a stringy state. The soln. applied on the member 11 is heated by a heater block set adjacent to the member 11 as a mechanism to heat the member 11. Consequently, the solvent in the soln. is rapidly vaporized, and a fine thin film is formed on the member 11.



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CLAIMS

[Claim(s)]

[Claim 1] The process at which specific resistance guides the solution-like matter more than 105-ohmcm into the nozzle for regurgitation including the solvent which dissolves a thin film formation ingredient and said thin film formation ingredient, The thin film formation approach of having the process which installs a formed member in the direction of an axis of said nozzle, and the process which electrostatic force is made acting in the direction of an axis of said nozzle to the solution-like matter in said nozzle, and carries out the regurgitation of said solution-like matter by the shape of **** toward a formed member from said nozzle.

[Claim 2] The thin film formation approach according to claim 1 that the solution-like matter also contains the solvent which can further adjust specific resistance.

[Claim 3] The thin film formation approach of having the process which guides the solution-like matter containing macromolecule resin into the nozzle for regurgitation, the process which installs a formed member in the direction of an axis of said nozzle, and the process which electrostatic force is made acting in the direction of an axis of said nozzle to the solution-like matter in said nozzle, and carries out the regurgitation of said solution-like matter by the shape of **** toward a formed member from said nozzle.

[Claim 4] The thin film formation approach of having the process at which specific resistance guides the solution-like matter more than 105ohmcm into the nozzle for regurgitation including a metallic material solution and a dispersant, the process which installs a formed member in the direction of an axis of said nozzle, and the process which electrostatic force is made acting in the direction of an axis of said nozzle to the solution-like matter in said nozzle, and carries out the regurgitation of said solution-like matter by the shape of **** toward a formed member from said nozzle.

[Claim 5] The thin film formation approach according to claim 4 that the solution-like

matter also contains a protective colloid or emulsion stabilizer further.

[Claim 6] Claims 1-5 in which the process which carries out the regurgitation of the solution-like matter by the shape of **** also includes the process on which a pressure wave is made to act further are the thin film formation approaches of a publication either.

[Claim 7] Furthermore, claims 1-6 which have the process which heats the solution-like matter breathed out on the formed member are the thin film formation approaches of a publication either.

[Claim 8] Furthermore, claims 1-7 which have the process which supplies inert gas to the perimeter of the solution-like matter breathed out on the formed member are the thin film formation approaches of a publication either.

[Claim 9] either of claims 1-8 -- the thin film deposition system which has the formed member in which a thin film is formed, the stage in which said formed member is laid, and a heating means to heat said formed member, from the source of supply of the solution-like matter of a publication, the solution-like matter regurgitation means which carries out the regurgitation of said solution-like matter, and said breathed-out solution-like matter.

[Claim 10] Furthermore, they are the 1st migration means movable in the 1st direction which connects said solution-like matter regurgitation means and a formed member for a solution-like matter regurgitation means, and the thin film deposition system according to claim 9 which has the 2nd movable migration means for a stage at a 2-way in the flat surface where said 1st direction is perpendicular.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] About the thin film formation approach and a thin film deposition system, from a minute nozzle, especially this invention makes the solution-like matter breathe out, and may be used for a hybrid IC circuit, a semiconductor circuit, or the suitable film formation process for micro machine manufacture about the approach of forming a thin film (100 micrometers or less, generally [a wide sense] thickness 10 micrometers or less) in a substrate etc.

[0002]

[Description of the Prior Art] Although development of the drop regurgitation equipment which makes ink breathe out from the former, using a minute nozzle as equipment for printing is prosperous, development of the drop regurgitation equipment or the circuit formation approach of making the solution made to breathe out as application of the drop regurgitation equipment apply to creation of IC circuit etc., using resists other than ink as a solution is made increasingly in recent years.

[0003] Hereafter, as a conventional technique, the liquefied matter coater of JP,5-104052,A is made into an example, and is explained.

[0004] Drawing 9 shows the configuration which JP,5-104052,A indicates. In drawing 9, the X-Y stage to which the discharge head by which 101 was connected to the liquefied goods feed zone, and 102 was connected to the liquefied matter feed zone 101, and 103 carry out a coated member (it is described as a substrate below.), and 104 carries out opposite positioning of a discharge head 102 and the substrate 103 is shown.

[0005] Moreover, a discharge head 102 has the diaphram 110 formed in the boundary of the pressure room 106 where it is open for free passage to the liquefied matter feed zone 101, and the liquefied matter 105 is filled, the nozzle 107 which it is prepared in the longitudinal direction halfway section of the pressure room 106, and carries out opening

to a discharge head 102 in a lower limit side, the displacement magnification room 109 which a variation rate is given and amplifies the variation rate by the piezoelectric device 108, and the pressure room 106 and the displacement magnification room 109.

[0006] and the variation rate which drove the piezoelectric device 108 by the control section 111, and was generated by it -- a variation rate -- pass the magnification room 109 and diaphram 110 -- it is transmitted to the liquefied matter 105 in the pressure room 106, and the liquefied matter 105 in the pressure room 106 is pressurized, and from a nozzle 107, the liquefied matter 105 will be set to drop 105a, and will be flown caudad.

[0007] By taking such a configuration, the liquefied goods 105 in a nozzle 107 are set to drop 105a, and it flies on a substrate 103 and makes it possible to apply the liquefied matter 105 by the pattern of arbitration on a substrate 103.

[0008] In addition, X-Y stage 104 is controlled by the control section 111 by the desired location.

[0009]

[Problem(s) to be Solved by the Invention] By the way, with the above-mentioned conventional configuration, since the piezo-electric effect is mainly used as the approach of the regurgitation, the technical problem which should be conquered as shown below occurs.

[0010] That is, by the regurgitation approach by the pressure impression type (it is described as a piezo-electric formula below.) using the piezo-electric effect, since the solution breathed out becomes the discharged liquid drop of one 3 times [twice to] the diameter of the diameter of a nozzle of this, it will receive a limit in detailed-izing and precision of a circuit pattern which are formed of discharged liquid.

[0011] Next, in order to raise detailed-izing and precision of a circuit pattern, the diameter of a nozzle must be made small, but when the diameter of a nozzle is made small, since adhesion loss in the nozzle section is large, by the regurgitation approach of a piezo-electric formula, a limitation is especially in a hyperviscous solution to make the diameter of a nozzle small.

[0012] And if an organic solvent with many amounts of dissolved air etc. is used as a regurgitation solution by the regurgitation approach of a piezo-electric formula, since a cavitation phenomenon will arise and the stability of the regurgitation will be lost, the class of solution which can carry out the regurgitation is restricted sharply etc.

[0013] This invention does not solve the technical problem of the above-mentioned conventional technique, and aims at offering the thin film formation approach and thin film deposition system which form a thin film using solution regurgitation equipment,

without receiving constraint of the class of solution.

[0014]

[Means for Solving the Problem] The process at which specific resistance guides the solution-like matter more than 105-ohmcm into the nozzle for regurgitation including the solvent in which this invention dissolves a thin film formation ingredient and said thin film formation ingredient in order to solve the above-mentioned technical problem, It is the thin film formation approach of having the process which installs a formed member in the direction of an axis of said nozzle, and the process which electrostatic force is made acting in the direction of an axis of said nozzle to the solution-like matter in said nozzle, and carries out the regurgitation of said solution-like matter by the shape of **** toward a formed member from said nozzle.

[0015] At this time, the solution-like matter may also contain the solvent which can further adjust specific resistance. Or you may be the thin film formation approach of having the process which guides the solution-like matter containing macromolecule resin into the nozzle for regurgitation, the process which installs a formed member in the direction of an axis of said nozzle, and the process which electrostatic force is made acting in the direction of an axis of said nozzle to the solution-like matter in said nozzle, and carries out the regurgitation of said solution-like matter by the shape of **** toward a formed member from said nozzle.

[0016] Or the process at which specific resistance guides the solution-like matter more than 105-ohmcm into the nozzle for regurgitation including a metallic material solution and a dispersant, You may be the thin film formation approach of having the process which installs a formed member in the direction of an axis of said nozzle, and the process which electrostatic force is made acting in the direction of an axis of said nozzle to the solution-like matter in said nozzle, and carries out the regurgitation of said solution-like matter by the shape of **** toward a formed member from said nozzle.

[0017] At this time, the solution-like matter may also contain a protective colloid or emulsion stabilizer further. And in the above configuration, the process which carries out the regurgitation of the solution-like matter by the shape of **** may also include the process on which a pressure wave is made to act further.

[0018] Furthermore, in the above configuration, you may have the process which heats the solution-like matter breathed out on the formed member.

[0019] Furthermore, you may have the process which supplies inert gas to the perimeter of the solution-like matter breathed out on the formed member.

[0020] Moreover, this invention is a thin film deposition system which has a suitable configuration to enforce the above thin film formation approach.

[0021]

[Function] By taking the configuration of the above this invention, constraint is not substantially received in the class of solution which can carry out the regurgitation.

[0022] Furthermore, since a regurgitation solution will be in a **** condition (the condition of pulling and carrying out the regurgitation of the yarn is said.) certainly, detailed thin film formation is carried out.

[0023]

[Example] Hereafter, the example of this invention is explained to a detail, referring to a drawing.

[0024] (Example 1) Specific resistance explains hereafter the thin film formation approach which used the solution more than 105-ohmcm as the 1st example of this invention.

[0025] Drawing 1 is the explanatory view showing the discharge condition at the time of making a solution breathe out using electrostatic force.

[0026] In drawing 1 , in 1, 4, and 6, a nozzle and 2 show a coated member and 3-7 show the discharge condition of a solution.

[0027] If a solution is made to breathe out using electrostatic force, if the discharge condition divides roughly, it can consider a gestalt as shown in drawing 1 .

[0028] That is, they are the condition of becoming the drop 3 which became independent of the (a) nozzle 1, and adhering to the discharge coated member 2, the condition of producing a **** phenomenon and adhering to the discharge coated member 2 so that the yarn shown in the (b) nozzles 4-5 may be pulled, or three gestalten of condition ** which adheres to the discharge coated member 2 in the shape of spraying as shown in the (c) nozzles 6-7.

[0029] Although the solution needed to be made to breathe out in the condition of producing the **** phenomenon of the above (b) in order to perform detailed thin film formation, it became clear by experiment of an artificer that a discharge condition was dependent on the specific resistance of a solution.

[0030] Hereafter, the contents of an experiment are explained. A solution is breathed out by electrostatic force and drawing 2 R> 2 is the block diagram showing the fundamental configuration for being applied.

[0031] In drawing 2 , the coated member in which a thin film is formed with the solution which adhered in 8 to a solution feed hopper and 9, and adhered in a solution delivery and 10 to a solution and 11, the back plate with which 12 was installed in the tooth back of the coated member 11, and 13 show a nozzle, and 14 shows a high voltage power supply.

[0032] In this configuration, a solution 10 is breathed out in the direction of the coated member 11 from a nozzle 13 by the electric field which performed electrical-potential-difference impression by the high voltage power supply 14, and were generated between the back plate 12 and the nozzle 13.

[0033] Drawing 3 shows the discharge condition of a solution when drawing 2 breathes out a solution with the shown configuration using electrostatic force with the relation between specific resistance and applied voltage.

[0034] An axis of abscissa shows the field strength according [axis of ordinate] the specific resistance of a solution to electrostatic force, and the condition that a solution does not carry out the regurgitation of the a section, the condition (condition of drawing 1 (a)) which the b section serves as an independent drop and carries out the regurgitation, the condition (condition of drawing 1 (c)) which carry out the regurgitation of the c section to the letter of spraying, and the condition (the condition of drawing 1 (b)) that a solution carries out the regurgitation of the d section to the shape of **** are shown in drawing 3 .

[0035] As mentioned above, in order to form the thin film of a detailed pattern, it is necessary to carry out the regurgitation of the solution in the state of **** which can control a regurgitation solution.

[0036] Therefore, it turns out that it is a premise to choose first that whose specific resistance of a solution is more than 105-ohmcm, and it will be in the discharge condition in which good thin film formation is possible if it adjusts to the magnitude which becomes ****-like about the energy (field strength) further given to a solution so that it may be in the condition of the d section of drawing 3 .

[0037] For example, generally as for the MOD (Metallo-Organic Deposition) solution with which development is furthered as the capacitor for DRAM, or a charge of nonvolatile memory material, the sol gel solution, etc., the organic solvent of hydrocarbon systems, such as ethanol and a methanol, is added as a solvent, and, generally the specific resistance of these solutions is more than 107-ohmcm in recent years.

[0038] If the regurgitation is performed by the regurgitation [these solutions] approach using the conventional piezoelectric device, cavitation will arise and the good solution regurgitation will not be made, but if the regurgitation of the solution is carried out with the configuration of this example Since a solution has the high specific resistance more than 105-ohmcm so that clearly also from drawing 3 , the solution regurgitation in the stable **** condition is possible, and a piezo electric crystal thin film, a dielectric thin film, etc. can be directly formed in the location of the arbitration of a substrate,

without using an exposure process and an etching process.

[0039] Moreover, it is the same even if it makes a solution breathe out not with the configuration of drawing 2 but with a configuration as shown in drawing 4 .

[0040] Although the principle to which this configuration carries out the regurgitation of the solution by electrostatic force is the same as that of the configuration of drawing 2 , using metal membrane 15a currently formed in the top face of the coated member 15 as an electrode of one of the two for generating electric field differ, it can get down, and one of configurations can be chosen by the application.

[0041] Then, the above thin film formation approach is explained to a detail about the actually applied thin film deposition system.

[0042] Drawing 5 shows the configuration of the thin film deposition system of this invention. The solution discharge part where 17 makes a solution breathe out in drawing 5 , the coated member in which a thin film is formed by breathing out a solution, as for 18, The X-Y stage which closes a coated member if it is migration in order that the heater block whose 19 heats a coated member, and 20 may make the location of the arbitration on a coated member breathe out a solution and may form a thin film in it, The Z stage to which they close positioning of the vertical direction of the solution discharge part 17 if the heat insulation plate arranged in order that 21 may prevent conduction of the heat generated from the heater block 19, and 22 are possible, and the solution feed zone which 23 stores the solution which carries out the regurgitation, and supplies a solution to the solution discharge part 17 are shown.

[0043] Moreover, 24 shows the control section which performs solution discharge quantity control of the solution discharge part 17, temperature control of the heater block 19, and migration length control of X-Y stage 20 and Z stage 22.

[0044] In such an equipment configuration, after positioning of the solution discharge part 17 is made by Z stage 22, a solution is breathed out toward the coated member 18 according to the above-mentioned regurgitation principle from the solution discharge part 17. In this case, X-Y stage 20 will be moved after regurgitation completion in the middle of the regurgitation if needed.

[0045] And since the heater block 19 which is the heating device in which the coated member 18 is heated is established, after breathing out a solution on the coated member 18, by heating the coated member 18, it becomes possible to evaporate a solvent promptly and to form a thin film, and the time amount required in order to form a thin film can be shortened.

[0046] In addition, even if it adopts the approach of heating using a lamp as the heating approach etc., it is undoubted that the same effectiveness can be acquired.

[0047] Of course, it may come out enough in time by the desiccation under a room temperature, and, in a certain case, you may not heat.

[0048] Moreover, even if a substrate does not restrict monotonously but is a curved-surface-like thing etc., thin film formation is possible by the same approach.

[0049] Furthermore, even if it breathes out a solution which deteriorates the property which reacts with the moisture in atmospheric air etc. and itself has by adding the function to fill with inert gas the ambient atmosphere of the place which forms a thin film in addition to the equipment configuration shown in drawing 5 , a property can be held, without being influenced of atmospheric.

[0050] Differential pressure may be prepared the place which may enclose with a container the place which forms a thin film, for example as a means for filling with inert gas the ambient atmosphere of the place which forms this thin film, and may introduce inert gas by the pressure higher than atmospheric air into it, and forms a thin film using a vacuum pump etc., and into atmospheric air, and the place which forms a thin film may be filled with inert gas.

[0051] Moreover, the head of the solution discharge part 17 which carries out the regurgitation of the solution can also be used as the multi-nozzle head which made the nozzle plurality, and thin film formation by different solution will be performed to coincidence, or it will become possible to create two or more circuit patterns with fixed spacing to coincidence, and improvement in productivity can be aimed at.

[0052] (Example 2) The 2nd example of this invention is explained hereafter.

[0053] Although the example 1 described the solution with high (more than 105-ohmcm) specific resistance, this example describes the case where the regurgitation is carried out about the case where specific resistance is a low solution (below 105-ohmcm).

[0054] Since the specific resistance of the SrTiO3 sol gel solution which uses some things, for example, an acetic acid, as the main solvent in inside although marketed with the sol gel solution etc. was as low as about 4x103-ohmcm, it did not produce a **** phenomenon according to electrostatic force, and was not able to realize the stable solution regurgitation in the regurgitation according to the principle of an example 1.

[0055] This cause is considered because [acetate having become the ion dissociated in the solvent and having lowered specific resistance] is.

[0056] Then, for the purpose which raises specific resistance, when the isobutyl benzene which is a hydrophobic organic solvent was mixed at a rate of 1:1 as the 2nd solvent in this solution, specific resistance went up in 107-ohmcm, and the good solution regurgitation of it became possible so that it might be contained in the field d section of drawing 3 .

[0057] Thus, the solution in which the good regurgitation is possible is producible with electrostatic force by using the 2nd solvent aiming at carrying out specific resistance adjustment in addition to the 1st solvent in which a medium is dissolved well.

[0058] Generally, this 2nd solution has the good object which is an organic solvent with a polarity lower than the 1st solution, and makes friends with the 1st solution well, for example, organic solvents, such as aromatic hydrocarbon, such as aliphatic hydrocarbon, a naphthene hydrocarbon, monochrome or dialkyl naphthalene, and a phenethyl cumene, are suitable for it.

[0059] And the process after the regurgitation is the same process as an example 1, and can form a thin film.

[0060] (Example 3) The 3rd example of this invention is explained hereafter.

[0061] This example explains the regurgitation of a solution with comparatively high (10-20 or more cp) viscosity, especially a resin solution.

[0062] About the formation approach of a thin film of obtaining a resin thin film, various applications -- it can use, for example as mask material at the time of electronic-parts circuit manufacture -- can be considered by making the solution which dissolved resin breathe out on a coated member, and drying it after that.

[0063] And generally, viscosity was high, since they were 10-20 or more cp in many cases, when the regurgitation approach of the conventional piezo-electric formula was used, the regurgitation was impossible for these solutions, or there were many unstable things.

[0064] However, also with the viscosity of 20 - 30cp, when using the regurgitation approach using electrostatic force, when it was a resin solution, it became clear that a highly precise pattern was producible.

[0065] In addition, in a resin solution, a solution with the specific resistance of a solution lower than 105-ohmcm also exists.

[0066] When drawing 3 was referred to, it was thought impossible to carry out the regurgitation of the low resin solution of these specific resistance, but according to examination of this invention person about a resin solution, exceptionally, even when specific resistance was low, it became clear that a **** condition could be produced.

[0067] For example, although the specific resistance of the PVA water solution which added PVA (polyvinyl alcohol) 5% was about 500ohmcm, it was able to check the solution regurgitation of a **** condition by using the regurgitation approach using electrostatic force.

[0068] This reason can consider that not only resistivity but the magnitude of the molecular weight of the solute itself may influence as a physical-properties value-factor

which produces a **** phenomenon according to electrostatic force.

[0069] About a resin solution tending to produce a **** phenomenon, although it cannot necessarily say that the cause is clear, as the protein of a macromolecule pulls yarn, the resin of a macromolecule considers **** phenomena to be a lifting and a cone.

[0070] And the process after the regurgitation is the same process as an example 1, and can form a thin film.

[0071] as mentioned above, when resin is used for a regurgitation solution as a regurgitation solution Since thin film formation to which the usable range of resistivity was expanded substantially can be performed, To the mask formation at the time of the usual electronic-parts circuit manufacture needing two or more processes, such as spreading of resin, exposure, and etching, by performing thin film formation from a resin solution according to the regurgitation principle of this invention Mask formation is attained only at 1 time of a process, and big effectiveness can be obtained for reduction of the routing counter at the time of circuit manufacture, low-pricing of a circuit, etc.

[0072] (Example 4) The 4th example of this invention is explained hereafter.

[0073] This example explains how to make a metal thin film form. If the solution containing metaled impalpable powder can be breathed out on a direct coated member and a thin film can be formed, since direct formation of detailed wiring will be attained, big effectiveness will be obtained for the miniaturization of a circuit, and low-pricing.

[0074] When manufacturing the solution which contained the impalpable powder of this metal in stability, it is thought that what is necessary is just to make it suspend using a dispersant.

[0075] There is a surfactant as an example of a dispersant, it sticks to a **-liquid junction side and fall stability of the surface energy is carried out.

[0076] That is, by the suspension distributed by stability, since this surfactant forms an adsorption protective film in a particle front face, since it does not cause direct contact and a collision between each particles, electrical conductivity is low, namely, specific resistance can use it as the solution more than 105-ohmcm.

[0077] Moreover, although an adsorption protective coat can make only a surfactant form, the matter which strengthens a surface coat further also exists.

[0078] Generally, when those matter is called a protective colloid or emulsion stabilizer and ** adds such matter, the suspension in which the collision of impalpable powder was avoided certainly and the electric property was stabilized is producible.

[0079] As a protective colloid, plant gum, starch, alginate, protein, lecithin, the fiber system ether, polyvinyl alcohol, a polyvinyl pyrrolidone, a polyacrylic acid derivative,

colloid silicic acid, etc. are known.

[0080] In addition, generally, the dispersion liquid of a particle are called colloid when the magnitude of the particle is 0.1 micrometers or less, and from several micrometers, when it is the magnitude of about 0.1 micrometers, they are called the emulsion or the emulsion.

[0081] The dispersion liquid of such a particle are already marketed and used the Ag30wt% independent distribution ultrafine particle solution which made the solvent of toluene distribute the silver particle made from Vacuum metallurgy in this example.

[0082] This distributed particle was generated by gas evaporation, particle size is 0.1 micrometers or less, and since it distributes independently, without condensing, each particle distributed by colloid has the specific resistance of a solution as high as about 107-ohmcm.

[0083] When the dispersion liquid of this particle were made to breathe out in the shape of a coated member top using electrostatic force, the **** phenomenon arose good and the regurgitation was possible.

[0084] Then, when the dispersion liquid breathed out on the coated member were heated at 300 degrees C, dispersion liquid became a silver thin film with electrical conductivity.

[0085] The surfactant or protective colloid which had covered the silver particle melts with heat, and evaporates, and this is considered to be because for contact condensation of silver particles to have accomplished.

[0086] Of course, you may abbreviate to having mentioned this heating process above depending on the case.

[0087] Thus, even if the particle itself has the low property of specific resistance, the regurgitation can be carried out good according to a regurgitation solution, then electrostatic force, it is made the particle by which the coat was carried out with the insulating ingredient, thin film formation is possible, and since direct formation of detailed wiring can be performed, big effectiveness can be mentioned in wiring of a up to [a coated member with low-pricing or the curved surface of a circuit].

[0088] (Example 5) The 5th example of this invention is explained hereafter.

[0089] Although examples 1-4 showed the case where only electrostatic force was used as an approach of making a solution breathing out, in addition to electrostatic force, this example describes the case where vibration by a piezoelectric device etc. is further impressed to a solution auxiliary.

[0090] The nozzle which used electrostatic force and a pressure wave together is used for drawing 6 , and it shows the configuration which makes a solution breathe out.

[0091] In drawing 6 , in a piezo-electric element for 17 to generate a delivery in a solution and for 18 generate a pressure wave, and 19, a back plate and 22 show a high voltage power supply, and, as for a pressure room and 20, 23 shows the coated member, as for a solution feed hopper and 21.

[0092] In this configuration, if an electrical potential difference is impressed to a piezo-electric element 18, a piezo-electric element will bend and the volume of the pressure room 19 will change.

[0093] Volume change of this pressure room makes the solution in a delivery 17 produce a flow, when this flow is larger than a predetermined value, serves as a drop and is breathed out in the direction of a coated member.

[0094] Moreover, electric field are acting between the ink in the pressure room 19, and a back plate, and the force of attracting ink in the direction of a coated member is working.

[0095] The regurgitation of a solution is made, when electrostatic force is applied to a solution, or when both the pressure wave by the piezo-electric element and electrostatic force exist, and when it does not apply any force to a solution, either, it is held with the surface tension of a solution in the delivery.

[0096] The result of having examined the regurgitation of the solution at the time of using together the case of only electrostatic force and a pressure wave is shown in drawing 7 using this equipment.

[0097] In the curve shown in drawing 7 connecting the regurgitation start point of a solution and not giving the pressure wave by the piezo-electric effect to a solution, when what has the required electrostatic force (it corresponds [mm] in 2kV /of the field strength of drawing 3) of C point applies a pressure wave to a solution, the more D point has a large pressure wave, the more it shows that electrostatic force can be relatively made small.

[0098] Although the magnitude of the pressure wave given to a solution at this time changes with the quality of the material of PIEZO, a dimension, a liquid room configuration, the diameter of a nozzle, physical-properties values of discharged liquid, etc., when it says with the electrical-potential-difference value generally impressed to PIEZO, it is about 500V from 50V.

[0099] Rather than the case where only electrostatic force is made to act to a solution as the regurgitation approach of a solution, by applying a pressure wave to electrostatic force auxiliary, this experimental result can lower the regurgitation starting potential shown in drawing 3 R> 3 of an example 1, and shows that the large field in the condition of producing a **** phenomenon can be taken.

[0100] The above is explained using drawing 8 . Drawing 8 R> 8 shows the relation

between the resistivity of a solution at the time of applying the electrostatic force and the pressure wave which are shown according to E points of drawing 7 to a solution, and that of the applied voltage at the time of regurgitation initiation.

[0101] In drawing 8 , a broken line F is the regurgitation starting potential in the regurgitation method of only electrostatic force (equivalent to the curve A of drawing 3), and Curve G shows the regurgitation starting potential when applying a pressure wave to electrostatic force.

[0102] Since the regurgitation starting potential of a solution falls by applying a pressure wave to electrostatic force for a regurgitation means, the field in the condition that a solution produces a **** phenomenon can add to the field of the d section only in the case of electrostatic force, can add the part shown in the e section, and will become usable [the low solution of resistivity], and the width of face of selection of a regurgitation solution will be expanded as a result for it.

[0103] And the process after the regurgitation is the same process as an example 1, and can form a thin film.

[0104] Thus, if not only electrostatic force but a pressure wave is applied to a regurgitation solution, since the class of regurgitation solution will be further extended compared with the solution regurgitation approach of only electrostatic force, the class of thin film which can be formed becomes possible [obtaining breadth passive circuit elements, or the big effectiveness to manufacture of a micro machine].

[0105]

[Effect of the Invention] As stated above, according to this invention, the solution-like matter is used as a thin film formation ingredient. The piezo-electric effect is used for electrostatic-force independence or electrostatic force as assistance as a regurgitation means of a thin film formation ingredient. By making it evaporate by leaving the solution of a thin film formation ingredient in the state of **** on a formed member at heating of the solvent in discharge and a solution, or a predetermined time room temperature Since constraint is not substantially received to the class of solution which can carry out the regurgitation compared with the conventional thin film formation approach and a regurgitation solution will be in a **** condition, detailed thin film formation is possible, and the convenience brought about at the time of production of various circuits or a device is very large.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The explanatory view explaining the regurgitation principle of this invention

[Drawing 2] The block diagram for the regurgitation of the solution which materialized this regurgitation principle

[Drawing 3] The property Fig. of the regurgitation of the solution decided by relation of the specific resistance-electric field acquired by the configuration which materialized this regurgitation principle

[Drawing 4] Other block diagrams for the regurgitation of the solution which materialized this regurgitation principle

[Drawing 5] The whole thin film deposition system block diagram which materialized this regurgitation principle

[Drawing 6] Other block diagrams for the solution regurgitation which materialized this regurgitation principle

[Drawing 7] The property Fig. of the regurgitation of the solution decided by relation of the pressure wave-electrostatic force acquired by other configurations which materialized this regurgitation principle

[Drawing 8] The property Fig. of the regurgitation of the solution decided by relation of the specific resistance-electric field acquired by the configuration which materialized this regurgitation principle

[Drawing 9] The block diagram showing the conventional example

[Description of Notations]

17 Solution Discharge Part

18 Coated Member

19 Heater Block

20 X-Y Stage

22 Z Stage

23 Solution Feed Zone

24 Control Section

[Translation done.]